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Vowel Project: Analysis of a Native-Japanese Speaker

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VOWEL PROJECT: ANALYSIS OF A NATIVE-JAPANESE SPEAKER

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ABSTRACT

This paper is the culmination of a vowel analysis project that examined the pronunciation of a non-native speaker of English. Eleven vowels from Yuka, a native-Japanese speaker, were analyzed using the phonetic software, Praat, and were then compared to the pronunciation of general American English females (data from Peterson and Barney, 1952). Differences between the pronunciations are highlighted in this paper. These differences may become areas of difficulty and unintelligibility for Yuka. The pedagogical implications of these differences are discussed and suggestions are made for Yuka and her language teachers.

1.0 Project Background and Biography of Participant

Throughout Wardhaugh's (2010) book on sociolinguistics, the idea of language variation is ubiquitous. Most people realize that variation exists when they travel to different parts of their own country and hear a variety of accents. In the United States, for example, one can hear distinct accents in specific cities, like New York or Boston, as well as specific regions, like the Deep South. The differences between these accents can most strongly be attributed to the vowel sounds. Vowels are not articulated in areas as easily classified as consonants. According to Fromkin and Rodman (1998), "vowels are produced without any articulators touching or even coming close together" (as cited in Koffi, 2012). Due to this, there is more difficulty in determining what occurs when a vowel is produced, and hence more room for variation. To more closely understand these variations, we first carried out an analysis of our own vowel pronunciations. For this project, we analyzed the English vowels of a non-native speaker of English.

We used the software, Praat v5329, developed by Paul Boersma and David Weenik (http://www.fon.hum.uva.nl/praat/), to analyze the data for this report. The version used is specifically made for the Windows operating system. The program was downloaded and used on a Hewlett-Packard Mini Notebook PC. The built-in internal microphone was used for all speech recordings. The recordings took place in a conference room at Saint Cloud State University during normal school hours.

Our participant in this project is an international student from Hokkaido, Japan. For the purposes of anonymity, we will call her Yuka. Yuka is a 28-year-old female and has been in the U.S. for one and a half years. Before coming to the U.S., Yuka was working as a veterinary technician in Japan. After two years of planning, Yuka came to Minnesota to study special education. During her first year of university in St. Cloud, she was enrolled in the College ESL program and took part in many extracurricular activities on campus. She met most of her friends through classes and activities, most of whom are native speakers of English. Two of her closest friends are her former College ESL instructor and a tutor from the Write Place.

While Yuka does have friends in the U.S. from Japan, including her own sister, she primarily uses English to communicate. Being from Hokkaido, she speaks a dialect native to that region and there are some differences in pronunciation and vocabulary that make communication more difficult with other Japanese people. Prior to moving to the U.S., Yuka had visited

Minnesota for three months when she came to visit her sister. Her sister has lived in the U.S. for 10 years, and by Yuka's account, does not speak Japanese very well anymore. Both Yuka and her sister acknowledge their decline in Japanese, usually communicating with each other in English. This decline has led Yuka to feeling embarrassed when communicating with her parents in Japanese.

Yuka has had a positive attitude regarding both the English language and American culture. Her grandfather encouraged both her and her sister to learn English and study in the U.S. In terms of adapting to American culture, she felt positive and prepared because of her sister's experience, and because of a former English teacher that she had from America. She described her English proficiency level as a 3 out of 10 before arriving in the U.S., saying that she could write well, but lacked adequate oral communication skills. Now, she rates herself as a 7 out of 10, mostly due to an improvement in her listening and speaking skills. We have classified her as a high-intermediate/advanced speaker due to her standing in the university and from going through the College ESL Program.

2.0 Acoustic Analysis – Spectrograms

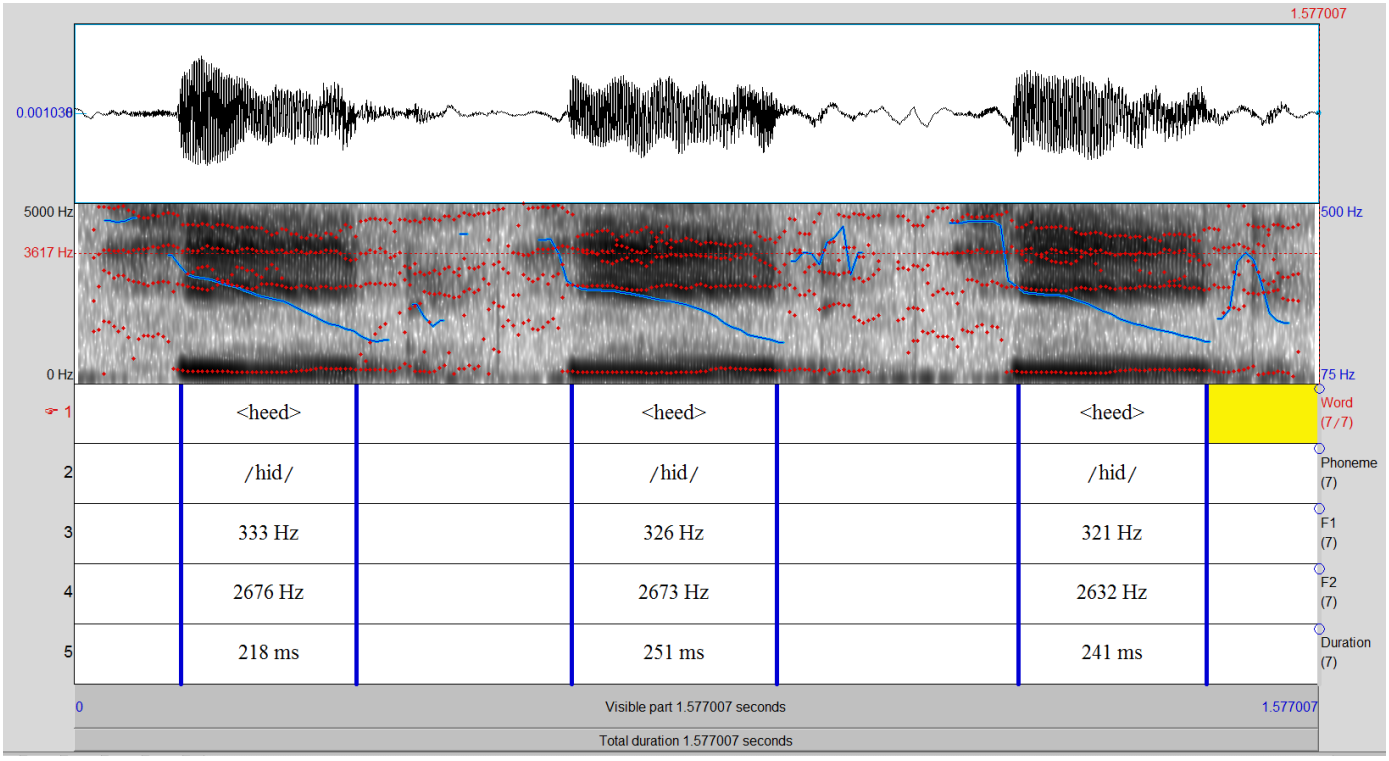

Figure 1: Praat spectrogram of the word <heed>

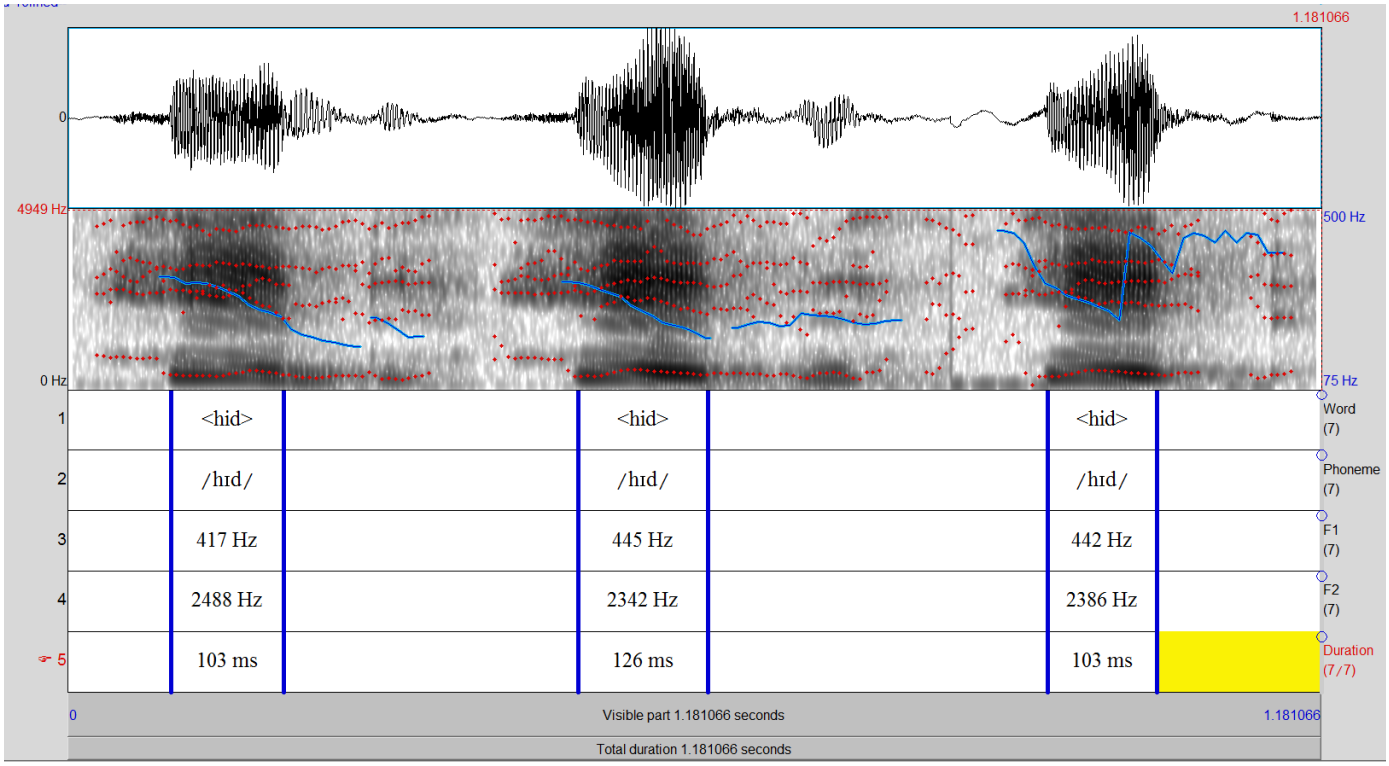

Figure 2: Praat spectrogram of the word <hid>

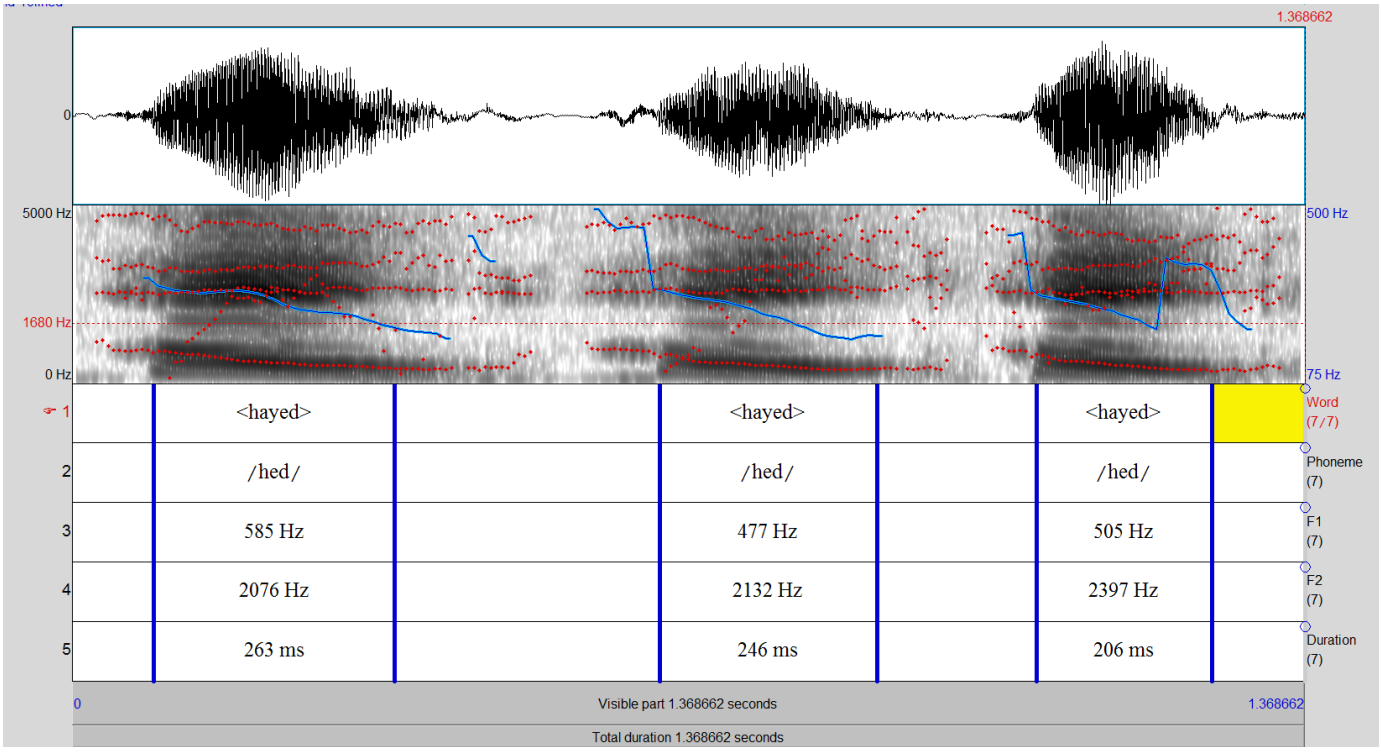

Figure 3: Praat spectrogram of the word <hayed>

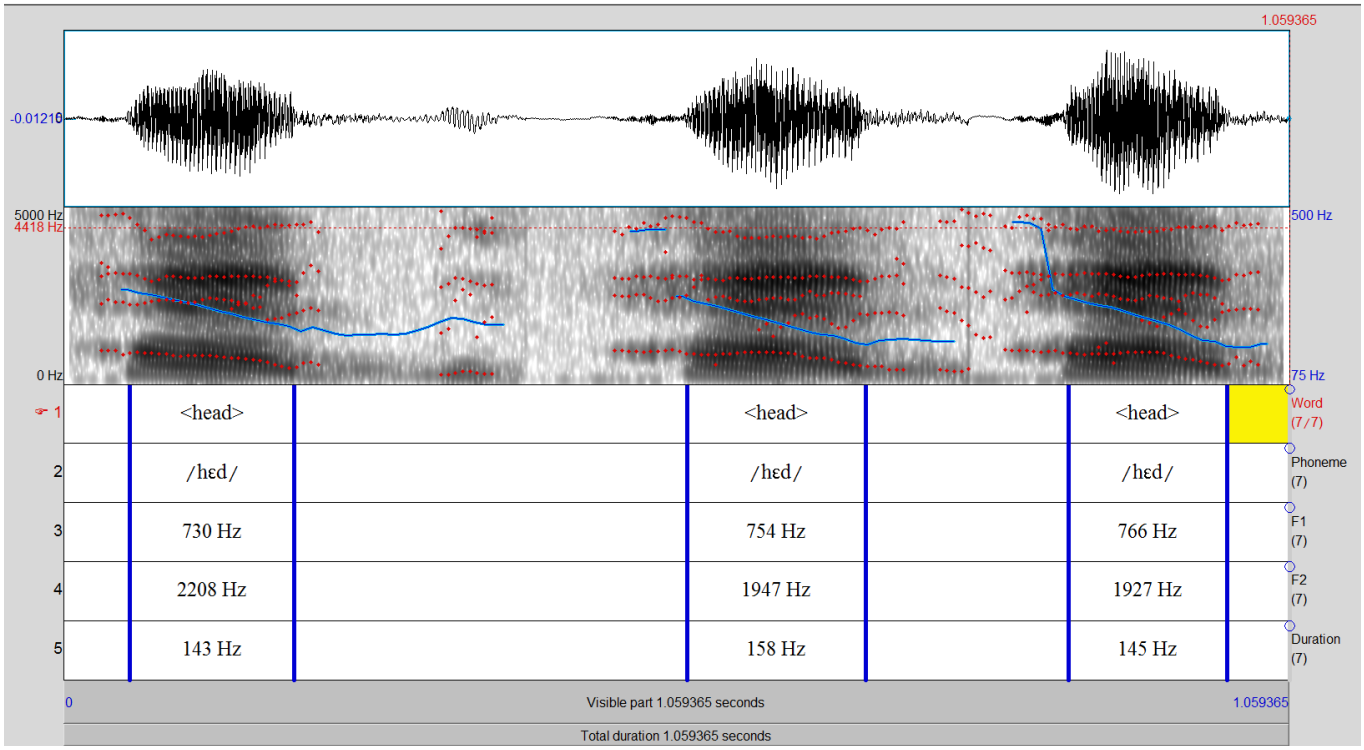

Figure 4: Praat spectrogram of the word <head>

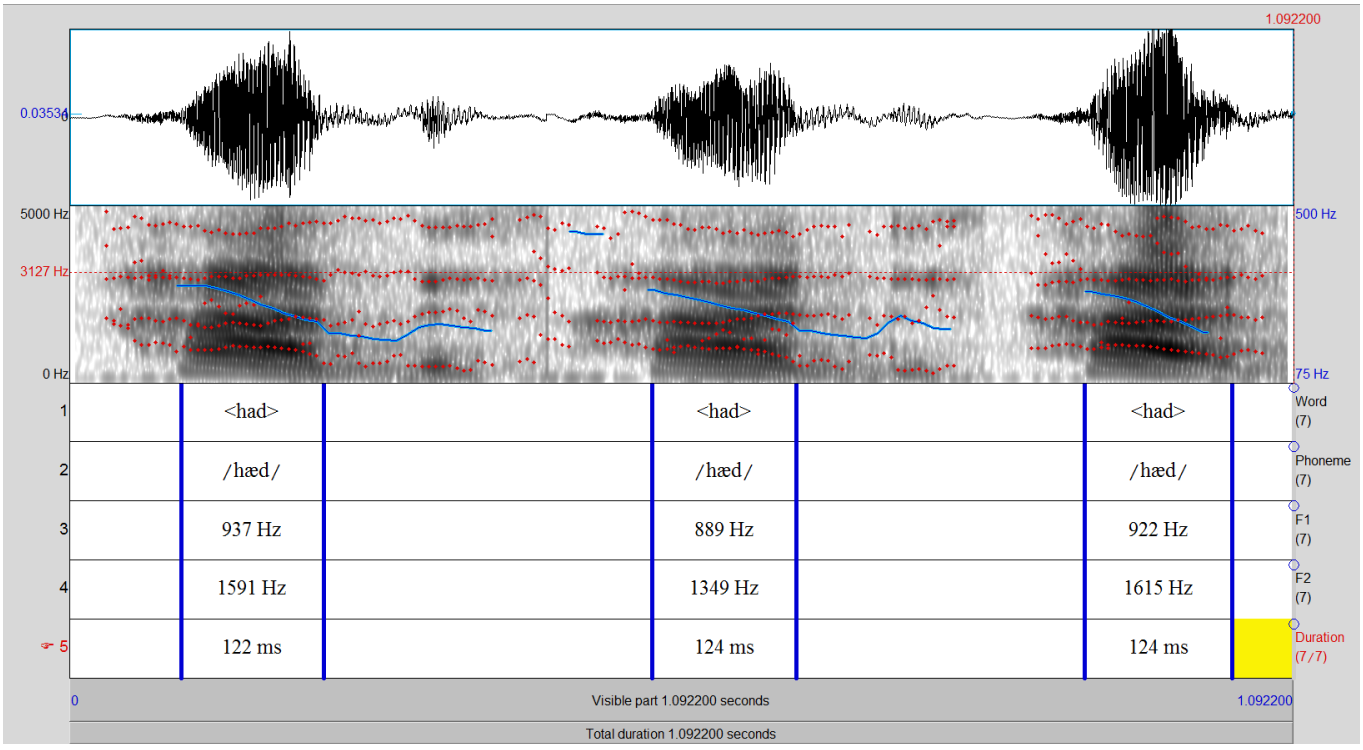

Figure 5: Praat spectrogram of the word <had>

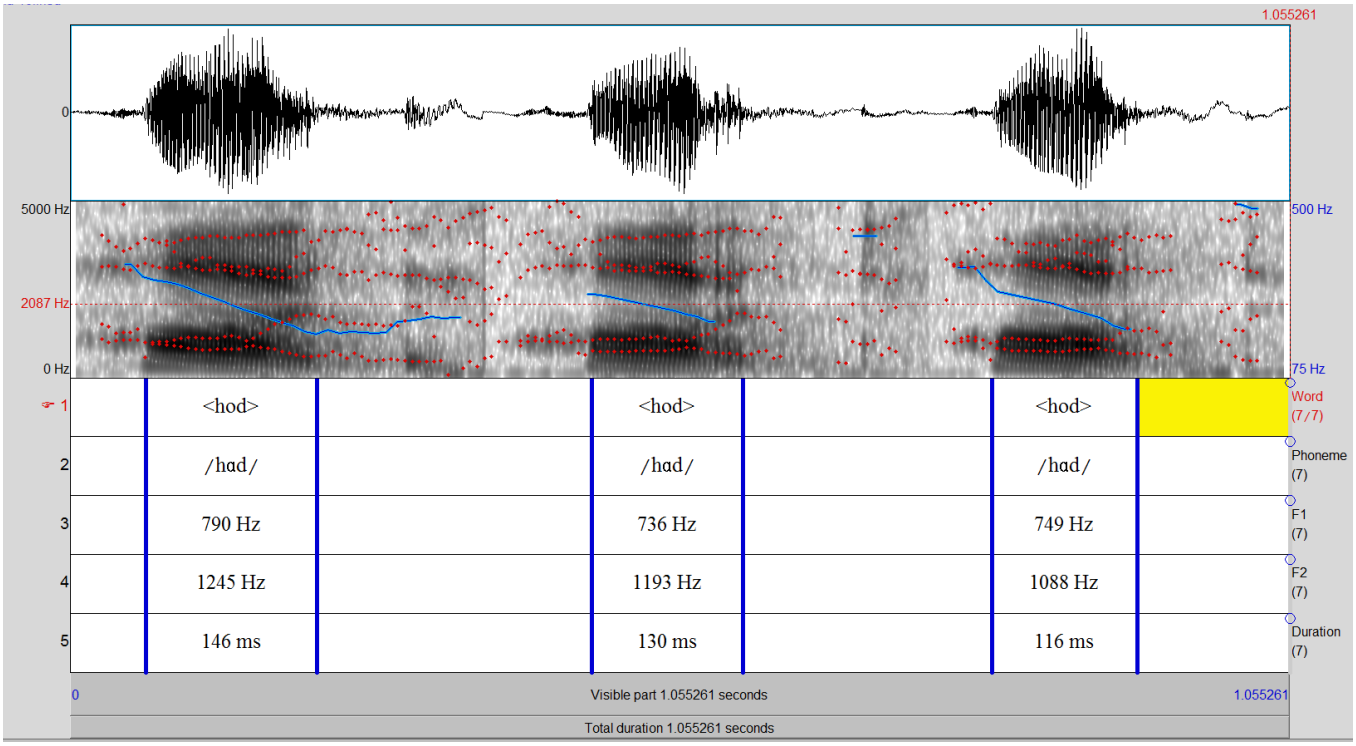

Figure 6: Praat spectrogram of the word <hod>

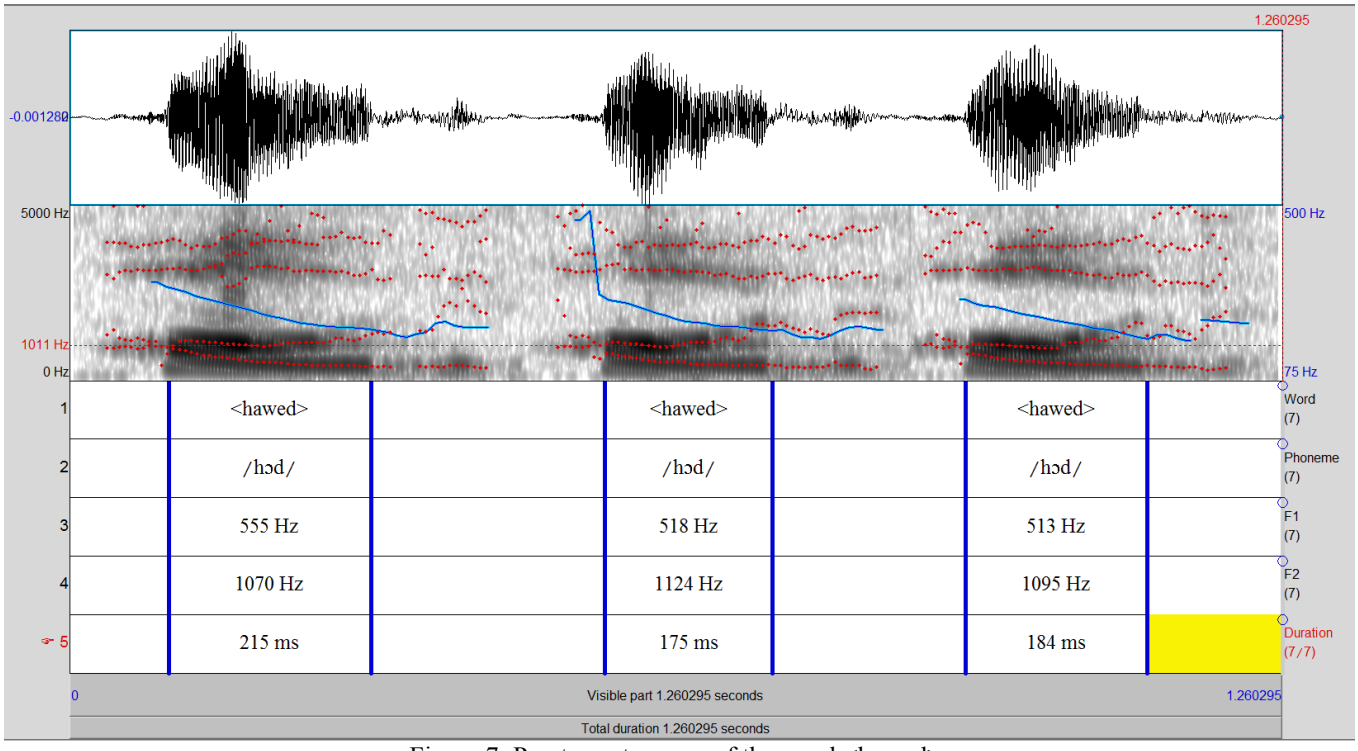

Figure 7: Praat spectrogram of the word <hawed>

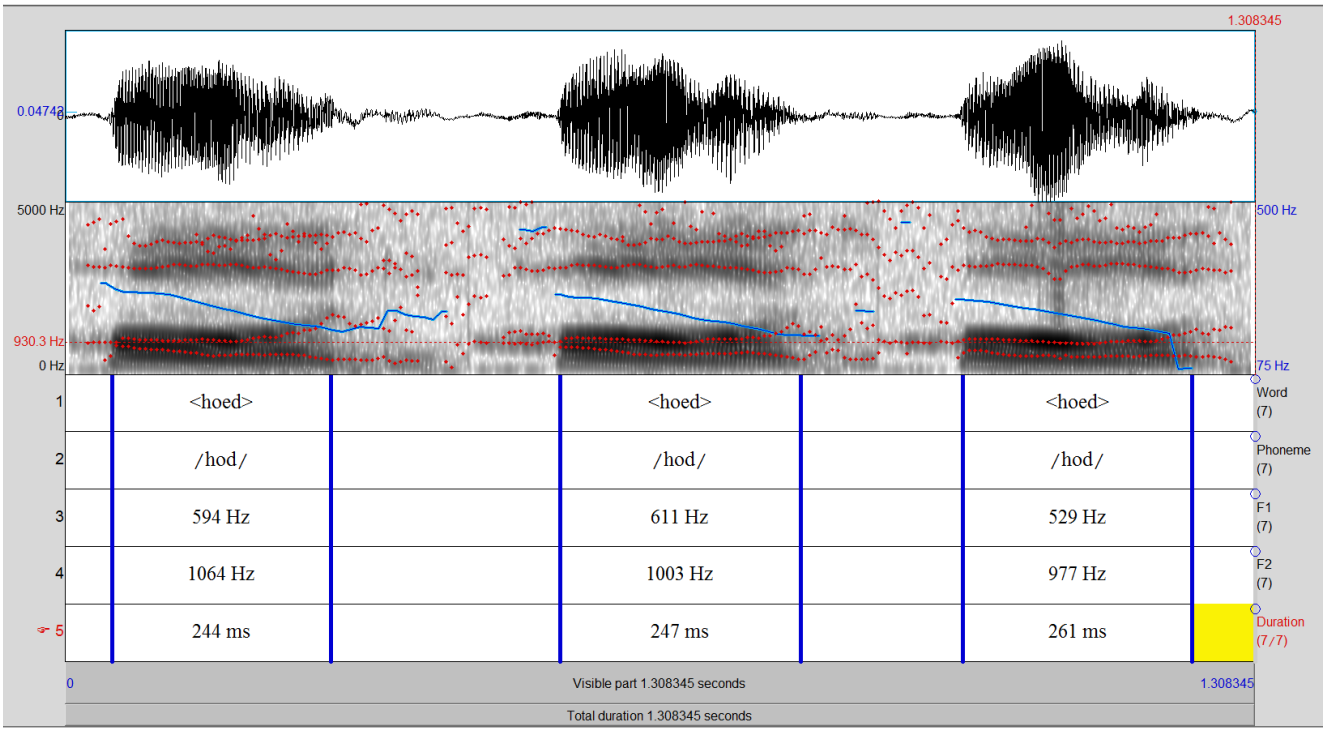

Figure 8: Praat spectrogram of the word <hoed>

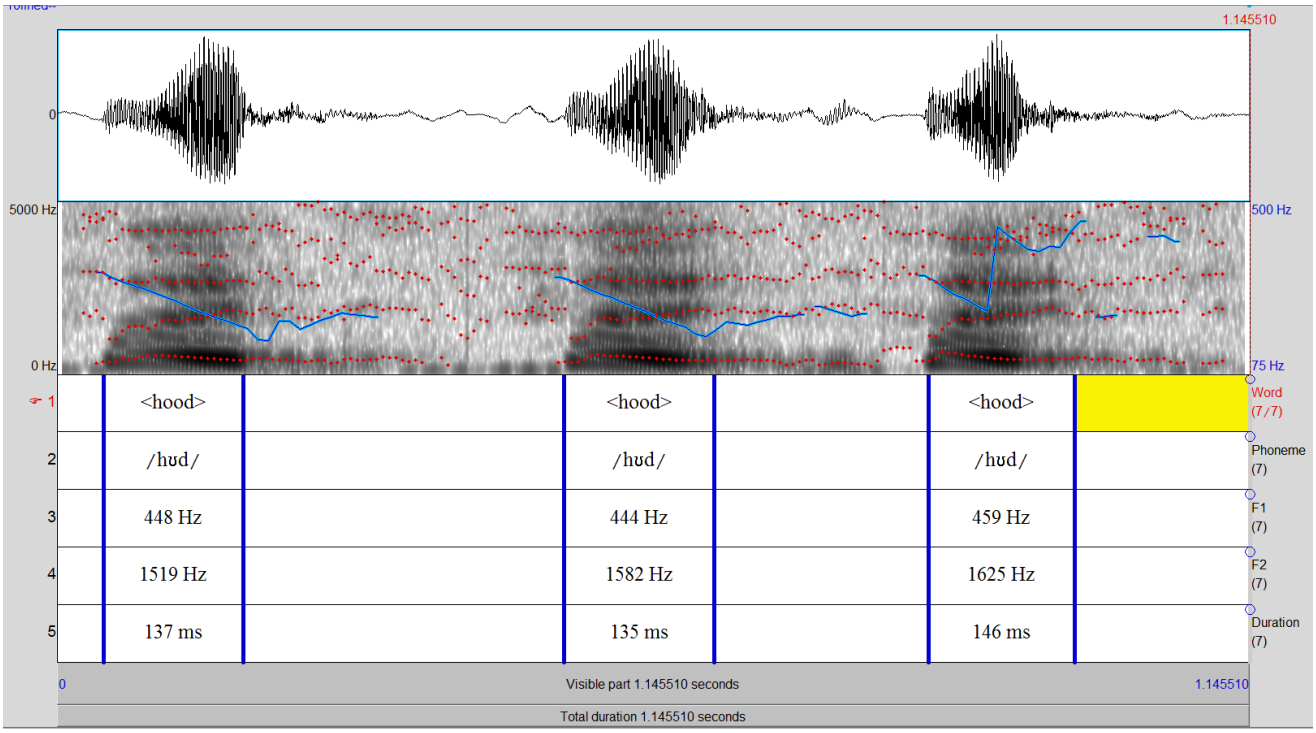

Figure 9: Praat spectrogram of the word <hood>

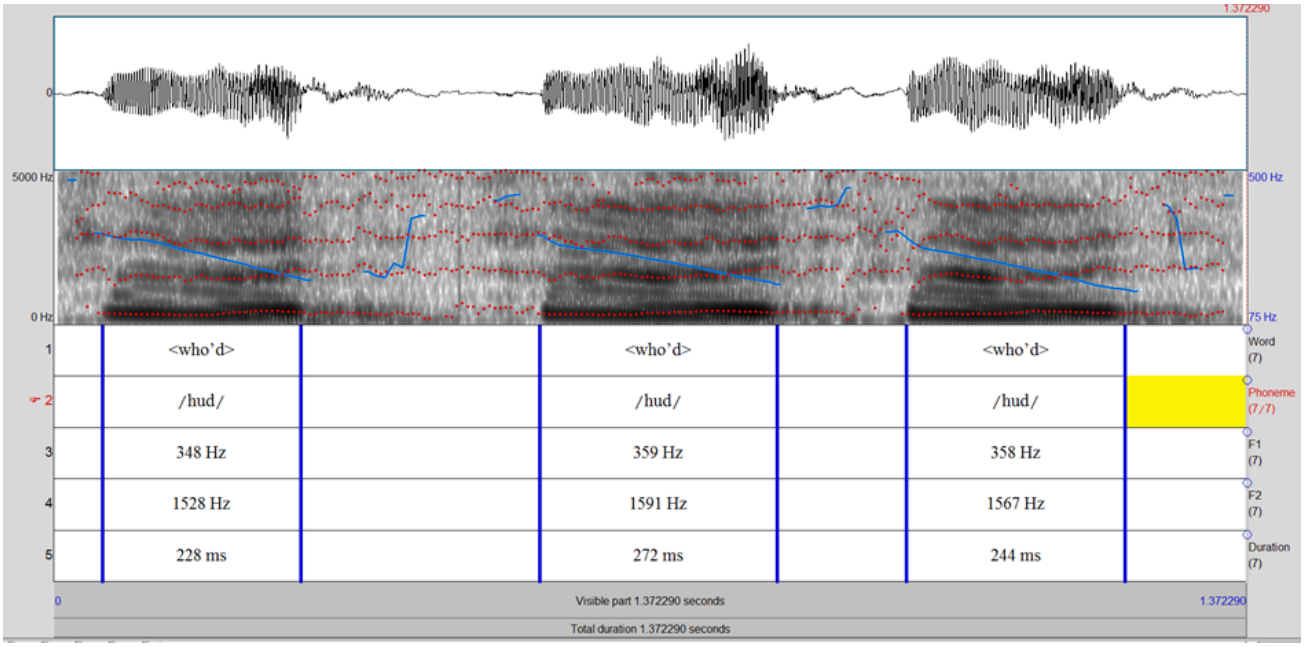

Figure 10: Praat spectrogram of the word <who'd>

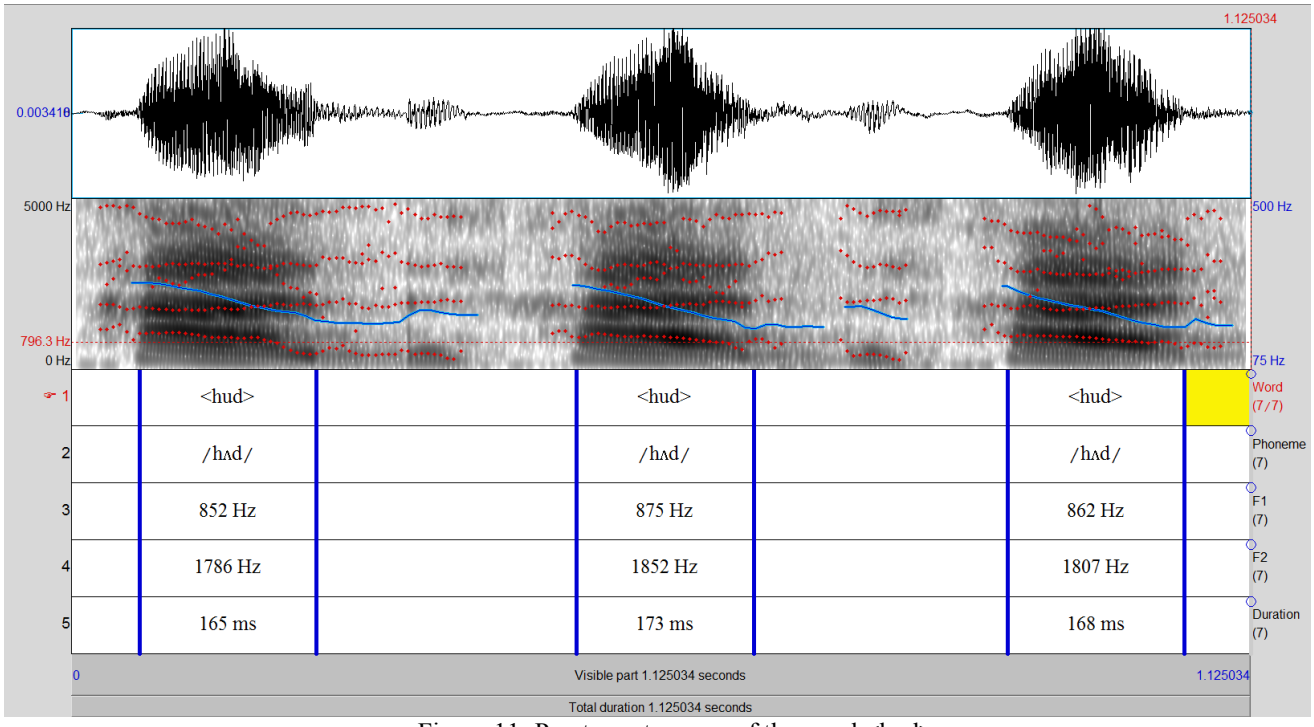

Figure 11: Praat spectrogram of the word <hud>

2.1 Acoustic Analysis – Vowel Table

GAE Female vs. Yuka Data

Words		heed	hid	hayed	head	had	hod	hawed	hoed	hood	who'd	hud
Vowels		[i]	[ɪ]	[e]	[ɛ]	[æ]	[ɑ]	[ɔ]	[o]	[ʊ]	[u]	[ʌ]
GAE	F1	310	430	536	610	860	850	590	555	470	370	500
GAE	F2	2790	2480	2530	2330	2050	1220	920	1035	1160	950	1640
Yuka	F1	327	435	522	750	916	758	529	578	450	355	863
Yuka	F2	2660	2405	2202	2027	1518	1175	1096	1015	1575	1562	1815
Duration		237	111	238	149	123	131	191	251	139	248	169

Table 1: GAE female data from Peterson and Barney (1952) and [e] and [o] from Midwestern female data from Hillenbrand et al. (1995)

2.2 Acoustic Analysis – Normalization Chart

speaker	vowel	context	F1	F2	F3	F1Glide	F2Glide	F3.Glide
Yuka	heed	heed	327.0	2660.0	1.000	327.0	2660.0	1.000
GAE Female	heed	heed	310.0	2790.0	1.000	310.0	2790.0	1.000
Yuka	hid	hid	435.0	2405.0	1.000	435.0	2405.0	1.000
GAE Female	hid	hid	430.0	2480.0	1.000	430.0	2480.0	1.000
Yuka	hayed	hayed	522.0	2202.0	1.000	522.0	2202.0	1.000
GAE Female	hayed	hayed	536.0	2530.0	1.000	536.0	2530.0	1.000
Yuka	head	head	750.0	2027.0	1.000	750.0	2027.0	1.000
GAE Female	head	head	610.0	2330.0	1.000	610.0	2330.0	1.000
Yuka	had	had	916.0	1518.0	1.000	916.0	1518.0	1.000
GAE Female	had	had	860.0	2050.0	1.000	860.0	2050.0	1.000
Yuka	hod	hod	758.0	1175.0	1.000	758.0	1175.0	1.000
GAE Female	hod	hod	850.0	1220.0	1.000	850.0	1220.0	1.000
Yuka	hawed	hawed	529.0	1096.0	1.000	529.0	1096.0	1.000
GAE Female	hawed	hawed	590.0	920.0	1.000	590.0	920.0	1.000
Yuka	hoed	hoed	578.0	1015.0	1.000	578.0	1015.0	1.000
GAE Female	hoed	hoed	555.0	1035.0	1.000	555.0	1035.0	1.000
Yuka	hood	hood	450.0	1575.0	1.000	450.0	1575.0	1.000
GAE Female	hood	hood	470.0	1160.0	1.000	470.0	1160.0	1.000
Yuka	who'd	who'd	355.0	1562.0	1.000	355.0	1562.0	1.000
GAE Female	who'd	who'd	370.0	950.0	1.000	370.0	950.0	1.000
Yuka	hud	hud	863.0	1815.0	1.000	863.0	1815.0	1.000
GAE Female	hud	hud	500.0	1640.0	1.000	500.0	1640.0	1.000

Table 2: GAE Female vs. Yuka Normalization Chart

2.3 Acoustic Analysis – GAE Female vs. Yuka Vowel Space

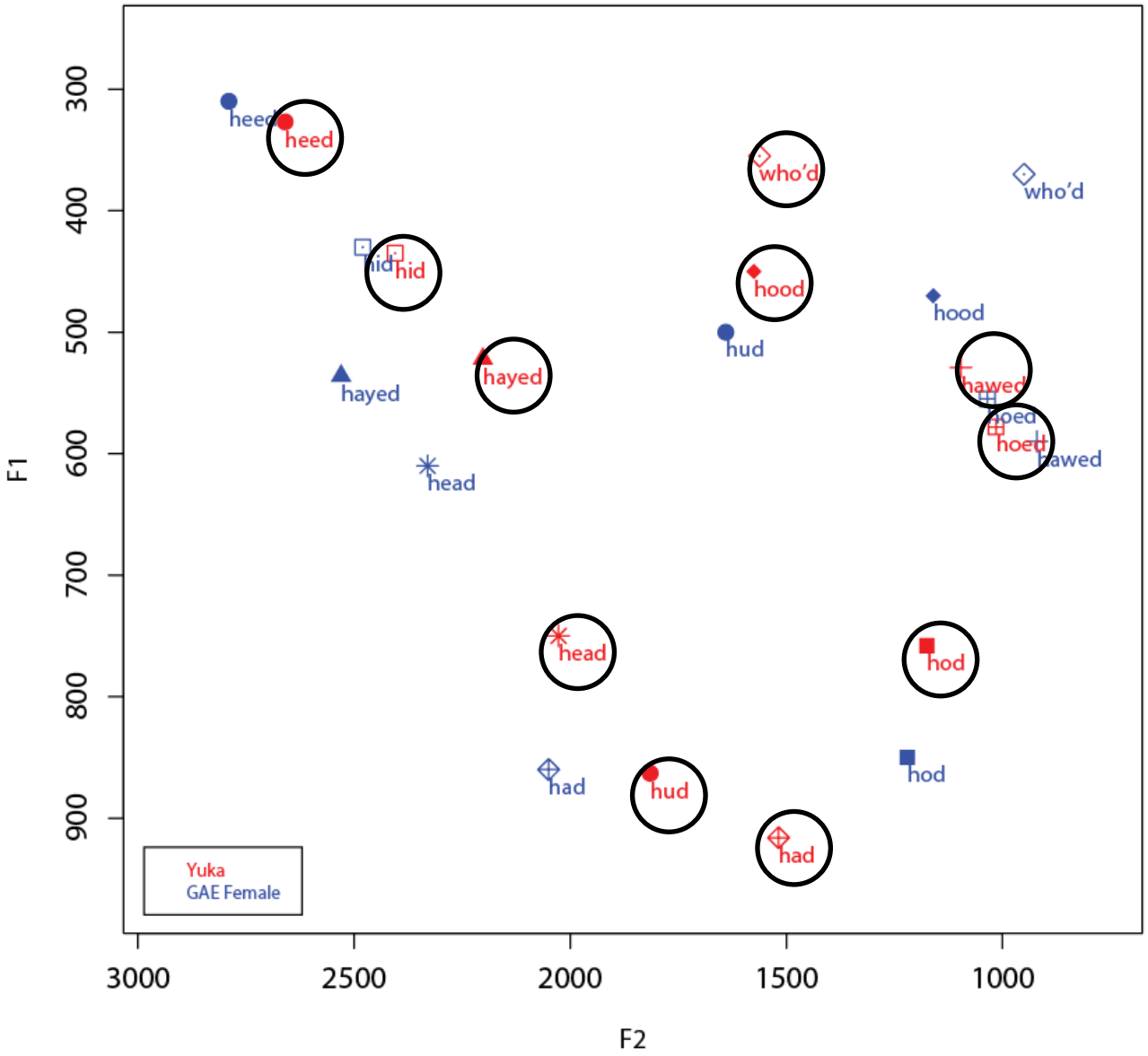

Figure 12: Normalization Vowel Space of Yuka (circled) vs. GAE Female

2.4 Acoustic Analysis – GAE Female vs. Yuka F1 and F2 Differences

Vowel Pairs	**F1 Frequency**	**F1 Difference**	**F2 Frequency**	**F2 Difference**
GAE [i] vs. Yuka's [i]	310-327	17 Hz	2790-2660	130 Hz
GAE [ɪ] vs. Yuka's [ɪ]	430-435	5 Hz	2480-2405	75 Hz
Midwest [e] vs. Yuka's [e]	536-522	14 Hz	2530-2202	**328 Hz**
GAE [ɛ] vs. Yuka's [ɛ]	610-750	**140 Hz**	2330-2027	**303 Hz**
GAE [æ] vs. Yuka's [æ]	860-916	56 Hz	2050-1518	**532 Hz**
GAE [a] vs. Yuka's [a]	850-758	92 Hz	1220-1175	45 Hz
GAE [ɔ] vs. Yuka's [ɔ]	590-529	61 Hz	920-1096	176 Hz
Midwest [o] vs. Yuka's [o]	555-578	23 Hz	1035-1015	20 Hz
GAE [ʊ] vs. Yuka's [ʊ]	470-450	20 Hz	1160-1575	**415 Hz**
GAE [u] vs. Yuka's [u]	370-355	15 Hz	950-1562	**612 Hz**
GAE [ʌ] vs. Yuka's [ʌ]	500-863	**363 Hz**	1640-1815	**175 Hz**

Table 3: F1 and F2 Differences – **F1 difference** > 135 Hz, **F2 difference** > 170 Hz

2.5 Acoustic Analysis – F1 and F2 Bar Graphs

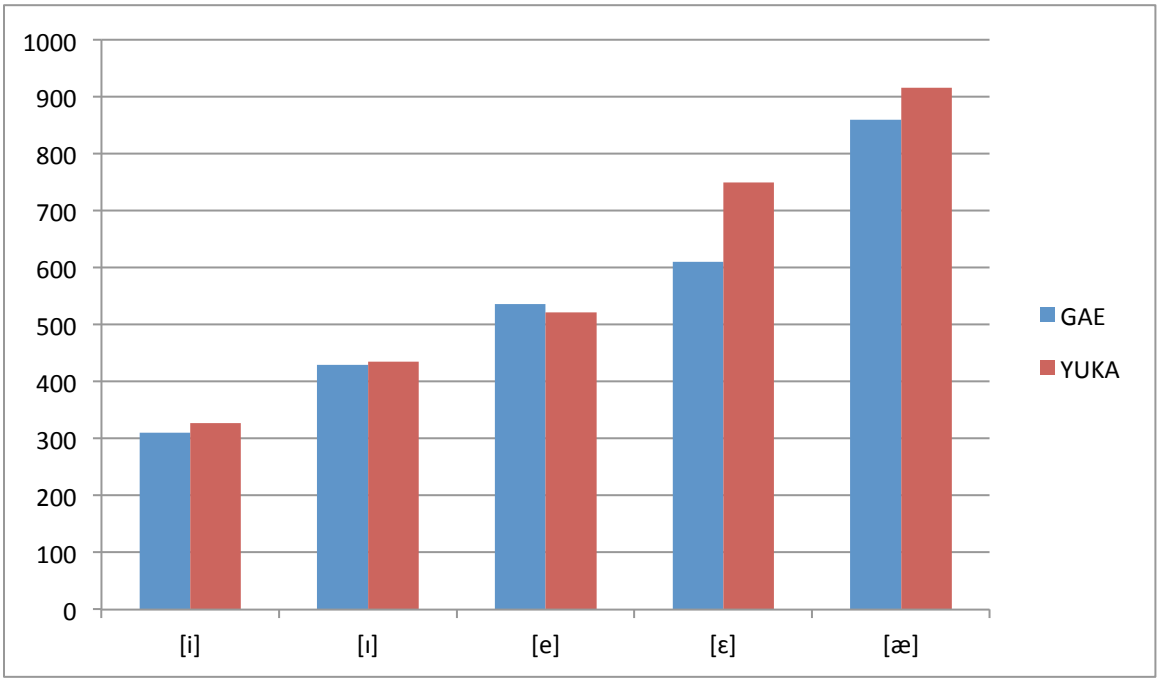

Figure 13: Front F1

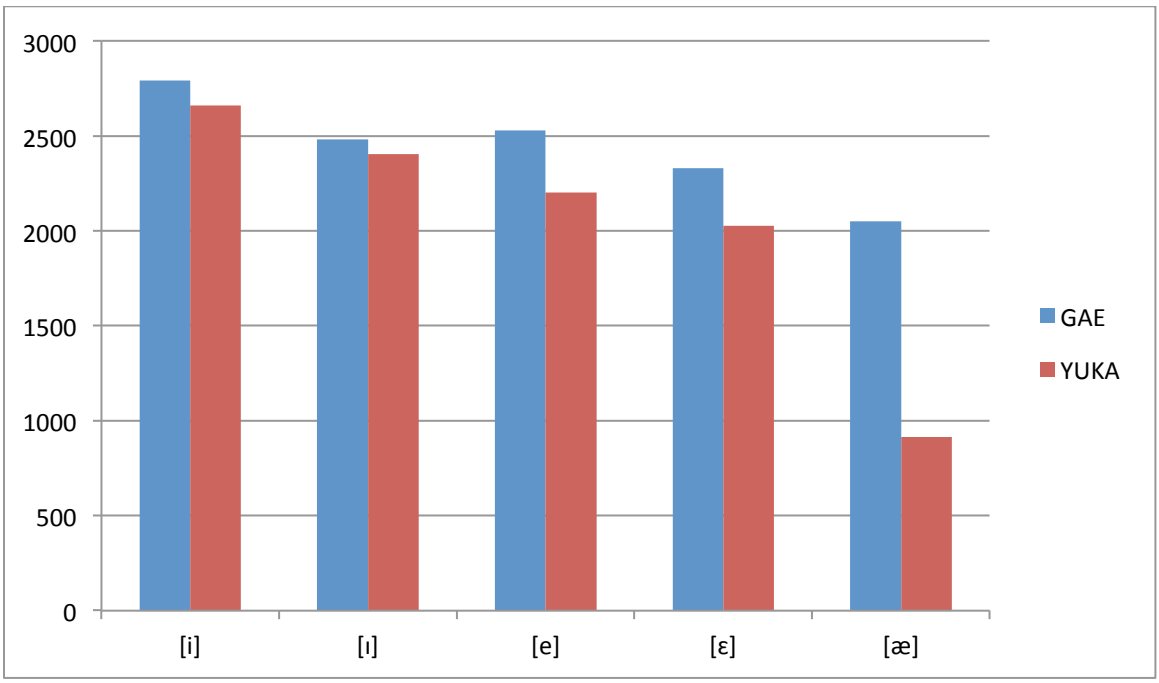

Figure 14: Front F2

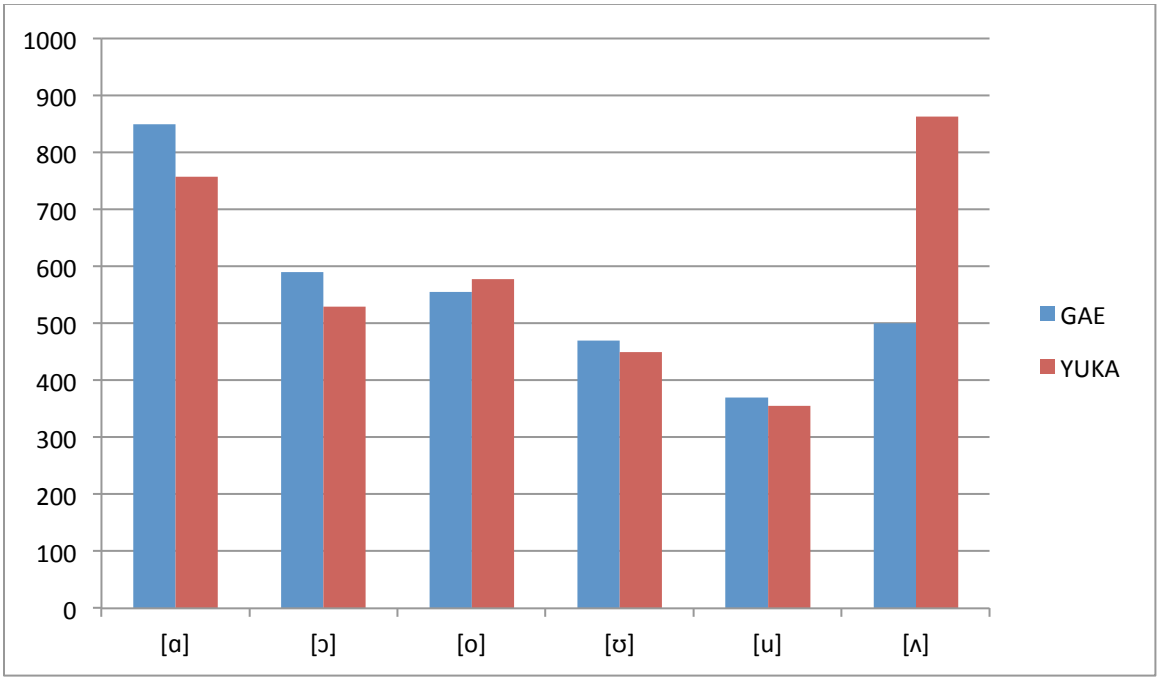

Figure 15: Back F1

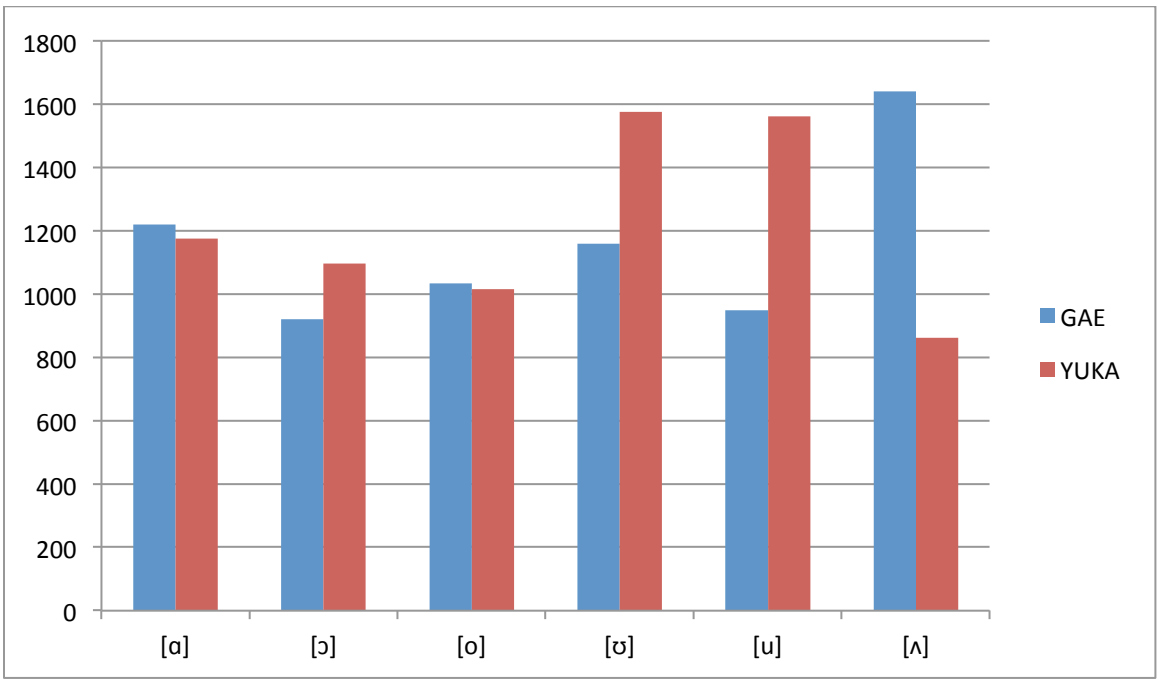

Figure 16: Back F2

3.0 L2 Intelligibility Assessment

Upon first glance of the vowel space of Yuka vs. the GAE female, it appears as though the two sets of vowel pronunciation are quite close. Further analysis of specific vowels, however, shows that there are several key differences between Yuka's pronunciation and the GAE female. These differences could be due to various factors, including L1 interference, assimilation of similar vowels, lack of comparable vowel sounds in the L1, lip roundedness, tongue height, and other individual characteristics. These differences in pronunciation could lead to the unintelligibility of several of Yuka's vowel pronunciations.

The first trend among Yuka's vowel pronunciation is that her front vowels have shifted back and the tongue height of these same vowels has lowered (except for /e/). Similarly, the majority of her back vowels have shifted forward in the mouth and the tongue height has raised. The combination of these two trends has led to an overall shrinking of Yuka's vowel space in comparison with the GAE female.

One notable exception to these trends is Yuka's pronunciation of /ʌ/. This vowel has dramatically lowered in tongue height while her other back vowels have raised in tongue height. According to research about native-Japanese speakers' pronunciation, this is not a surprising finding. Lambacher, Martens, Kakehi, Marasinghe, and Molholt (2005) found that the vowels /ɑ/ and /ʌ/ were particularly difficult for native-Japanese speakers to produce, even after receiving training. Interestingly, Yuka did not show any difficulties in pronouncing /ɑ/ and this vowel should be understood by others (the F1 and F2 differences were only 92 Hz and 45 Hz, respectively for Yuka's /ɑ/ versus the GAE female's /ɑ/).

Her drastic difference in pronouncing /ʌ/ could likely be due to differences in tongue height in Japanese pronunciation and American English pronunciation. In Japanese, there are only five vowel sounds, /i/, /e/, /a/, /o/, and /ɯ/. All of these sounds can be held out two or three times as long to produce a total of ten vowel sounds (Nishi, Strange, Akahane-Yamada, Kubo, &

Trent-Brown, 2008). These ten vowels are pronounced using three different tongue heights whereas the 10 or 11 vowels in American English are pronounced using five different tongue heights (Nishi et al., 2008).

In addition to tongue height, the difference in the pronunciation of /ʌ/ could also be due to a lack of comparable vowel sounds in Yuka's L1, Japanese. According to Lambacher et al. (2005), native-Japanese speakers often assimilate both the /ɑ/ and /ʌ/ sound in AE to resemble their L1 vowel, /a/. Since the tongue height for the pronunciation of the Japanese /a/ is lower than /ʌ/, it may explain why Yuka has lowered the tongue height in her pronunciation of /ʌ/. Also, since she is used to using only three different tongue heights in Japanese, she may not be used to positioning her tongue in the necessary position for the typical pronunciation of /ʌ/.

Further difficulty in intelligibility may be encountered with Yuka's pronunciation of /æ/. As we interviewed Yuka, this particular vowel stood out as being distinct and different from AE; she had a noticeably British pronunciation of /æ/, making it sound more like the AE pronunciation of /ɑ/ or /ɔ/ (which are merging in many American dialects). Nishi (2007) points out that the vowels /æ/, /ɑ/, and /ʌ/ are often assimilated with the Japanese vowel /a/ by native-Japanese speakers of English. It is interesting to note that the vowel space between Yuka's /æ/, /ɑ/, and /ʌ/ are much smaller than the GAE female, which agrees with Nishi's (2007) data, as illustrated in the diagram below:

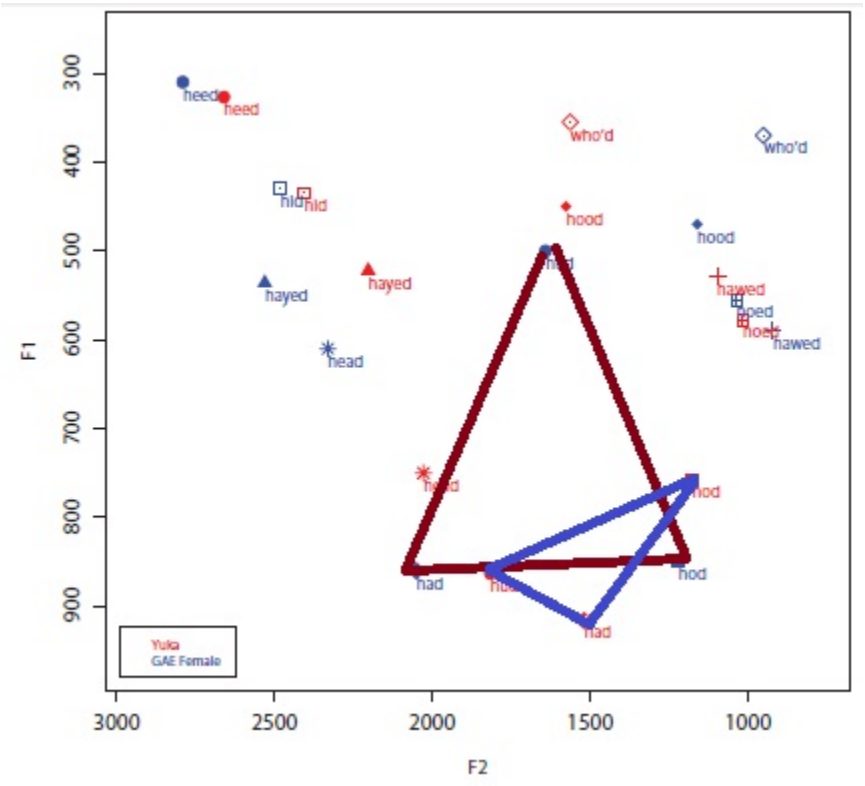

Figure 17: Comparison of Yuka and GAE Female /ʌ/, /æ/, and /ɑ/

Since these three vowels are pronounced in a relatively small area, it is likely that some listeners would not be able to distinguish between them.

Another problem area could be with Yuka's pronunciation of /ɛ/. According to Koffi (2012), "in evaluating vowel intelligibility, it is assumed that if the F1 and F2 frequencies between GAE and SoE vowel of the same type are lower or equal to 135 Hz and 170 Hz respectively, then the SoE vowel is intelligible" (p. 225). In Yuka's case, the F1 and F2 differences for her pronunciation of /ɛ/ in comparison with the GAE female are 140 Hz and 303 Hz, respectively. These numbers indicate that this particular vowel may be unintelligible to some people. Most likely, Yuka's /ɛ/ would be heard as /æ/ since the F1 and F2 frequencies of her /ɛ/ are closest to the GAE female /æ/. According to Lambacher et al. (2005), native-Japanese speakers have trouble perceiving and producing AE mid and low vowels, including /æ/.

Potential intelligibility issues could also arise in Yuka's pronunciation of /o/ and /ɔ/. Although her pronunciation of each of these vowels is distinct, her pronunciation of /ɔ/ is closer to the Midwest female pronunciation of /o/ than it is to the GAE /ɔ/. According to Ferrand (2007) and Ladefoged (1996), as cited in Koffi (2012), the human ear "cannot detect frequencies below 20 Hz" (p. 226). Therefore, the F1 difference of only 26 Hz between Yuka's /ɔ/ and the Midwest female /o/ would barely be detectable to most listeners.

Finally, listeners may have difficulty distinguishing between Yuka's pronunciation of /ʊ/ and the GAE female pronunciation of /ʌ/. The F1and F2 differences between these two vowels are only 50 Hz and 85 Hz, respectively. This difference in pronunciation could be due to the lack of lip rounding in Japanese pronunciation; only one vowel, /o/, in Japanese requires lip rounding (Nishi et al., 2008). A lack of lip rounding in Yuka's pronunciation of /ʊ/ may be causing it to sound more like /ʌ/.

4.0 Pedagogical Implications

Since the vowels [ɛ], [ʌ], and [æ] could be problematic for Yuka, it is crucial that she and her instructors focus their attention on these specific areas. Although these particular vowels have been identified as being potentially problematic, it is necessary to also identify what can be taught explicitly to Yuka. First, the previous section mentioned problems related to tongue height and lip rounding. Since both of these are somewhat visible, physical features, it may be possible to explicitly teach Yuka (or other native-Japanese speakers) to mimic the lip and tongue positions of native-English speakers.

Secondly, Nishi et al. (2008) compared English and Japanese diphthongs; English has five, whereas Japanese has zero. This alone shows a necessity for focused instruction and emphasis on the reception and production of English diphthongs by native-Japanese speakers. In terms of specific training on vowels, Nishi and Kewley-Port (2007) investigated the effects of training and instruction on native-Japanese speakers' perception of vowels. The study compared the gains of learners in an immersion context in which two groups received training and instruction, and one group did not. The two groups that received the instruction showed improvement, but the other group did not make significant gains. This study is an example of the benefits of focused instruction; it also illustrates the fact that an immersion context alone does not necessarily ensure that any improvement of vowel perception will take place. It is important to note that while focused instruction can help learners, Lambacher et al. (2005) found that learners had the most difficulty differentiating between /ɑ/ and /ʌ/ and made only minor improvements after training (p. 243).

Lambacher et al. (2005) also suggested that improvements in vowel perception and production could be achieved in two main ways: by providing immediate feedback and by using similar listening formats during both training and testing. While immediate feedback should be

easy to provide in an educational context, using a consistent listening format is not as feasible. With the variety of contexts in which listening and speaking English could be used by learners, this would be difficult to always provide.

A more realistic option would be to use contexts which reflect the future use of English for the individual. For example, learners planning to use English for academic purposes could benefit from listening to lectures and presentations.

Aside from making Yuka aware of these difficulties, her age may affect any improvement from explicit training. Oh et al. (2011) found that an adult group of native-Japanese speakers "did not change their English vowel production after one year's residence in the US, whereas the NJ (native Japanese) Child Group did" (p. 160). At 28-years-of-age, Yuka's pronunciation may already be fossilized. Another point is that since Yuka has completed the College ESL Program, she has completed her formal and explicit English instruction. Although she still has three more years of university, her feedback will most likely be limited to comments about grammar in writing since English proficiency is not the content focus of her area of study.

For teachers, these implications vary between EFL and ESL contexts. English vowel pronunciation issues are not limited to Japanese speakers, but the specific problem areas and the reason behind the issues are specific to native-Japanese speakers. For example, an EFL context would provide a homogeneous environment where these issues could be addressed as a whole class, such as focusing on English diphthongs or lip rounding. However, in an ESL context where there is a diverse group of learners, it may not be feasible to provide the proper emphasis on language-specific problem areas. Another area related to this issue is the educator's background knowledge in phonetics. Without the specific knowledge of how English vowels are produced, educators are reduced to a simple "repeat after me" that does not give the learner the tools to actually learn the proper pronunciation.

ABOUT THE AUTHORS

Rebekah Gordon is a current student in the SCSU master's TESL program. She completed her undergraduate degree in special education at the University of Wisconsin-Madison. After that, she spent two years teaching English in Incheon, South Korea and discovered her passion for language teaching. Upon completion of the master's program, she hopes to teach abroad again in either the Middle East or Asia. When not studying, Rebekah enjoys both indoor and outdoor activities, especially bicycling, inline skating, sewing, and crossword puzzles.

Edward Hart is in his second year of the MA-TESL program at SCSU. He graduated from St. John's University with a BA in Business Management in 2008. After, he taught in Hong Kong and southern China for one year. Although his background is in business, he prefers teaching. His hobbies include reading books and comic books, playing guitar, and completing puzzles.

Recommendation: This paper was recommended for publication by Professor Ettien Koffi, Ph.D., Linguistics Department, St. Cloud State University, St. Cloud, MN. Email: enkoffi@stcloudstate.edu

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